1. (4 pts) A business major tries to loosen a bolt by pushing as shown. What is the direction of his moment vector?

A. \(-\cos(50)\hat{i} - \sin(50)\hat{j}\)

B. \(+\cos(50)\hat{i} + \cos(50)\hat{j}\)

C. \(+k\)

D. \(-k\)

2. (4 pts) You sit on a rotating platform with your arms drawn in. What happens when you stretch your arms outward?

A. The rotation speed is unchanged

B. The rotation speed decreases

C. The rotation speed increases

3. (4 pts) A hollow sphere and a solid sphere are released from the same height at the same time and roll down a hill. Which one will reach the bottom first?

A. The hollow sphere

B. The solid sphere

C. Can't tell – depends upon the radius of each one

D. Can't tell – depends upon the mass of each one

E. Can't tell – depends upon the radius and the mass of each one

4. (4 pts) Which value of \(\theta\) will cause the greatest torque about point A?

A. 0°

B. 30°

C. 60°

D. 90°

E. 120°

F. 150°

G. 180°

5. (4 pts) A rotating object has an angular speed of \(\omega\). What is its speed if you double its kinetic energy?

A. 4\(\omega\)

B. 2\(\omega\)

C. 1.4\(\omega\)

D. \(\omega\)

E. 0.7\(\omega\)

F. 0.5\(\omega\)

G. 0.25\(\omega\)
5. (4 pts) An electric motor spins at a constant speed of 250 rpm while lifting a 0.50 kg weight a distance of 1.2 meters in 7.0 seconds. What is the torque exerted by the motor?

\[ T = \frac{F \cdot d}{t} = \frac{(0.5 \text{ kg})(1.8 \text{ m/s}^2)(1.2 \text{ m})}{7 \text{ sec}} = 0.184 \text{ Nm} \]

\[ P = F \cdot d = 4 \text{ W} \]

\[ P = F \cdot a \cdot t = 4 \text{ W} \]

\[ \omega = \frac{250 \text{ rpm}}{60 \text{ sec}} = 26.18 \text{ rad/sec} \]

\[ \tau = \frac{F \cdot \omega}{26.18 \text{ rad/sec}} = 0.0321 \text{ Nm} \]

6. (3 pts) What is the value for \( Y \) if the center of mass of the object is at point C?

\[ Y = \frac{3 \cdot m \cdot (X \text{ m})}{m} \]

\[ Y = \frac{3 \cdot 1 \cdot (2.5 \text{ m})}{2} = 3.75 \text{ m} \]

\[ Y = \frac{1}{2} \cdot (1.5 \text{ m}) + \frac{1}{2} \cdot (1.5 \text{ m}) \]

\[ Y = 1.5 \text{ m} \]

\[ Y = 5.01 \text{ m} \]

- 4 missing part of COE
- 2 wrong use of datum

7. (5 pts) A tennis ball (hollow sphere) starts from rest at point A and rolls without slipping down a ramp as shown. What is the speed of its center of mass at point B?

(Hint: you do not need the mass or radius for this problem)

\[ v_B = 4.47 \text{ m/s} \]

\[ F_{E_A} = F_{E_B} + K_{E_B} + K_{E_B} \]

\[ mgh_A = mgh_B - \frac{1}{2} m v_B^2 + \frac{1}{2} I w_B^2 \]

\[ mgh_A = mgh_B - \frac{1}{2} m v_B^2 + \frac{1}{2} I \omega_B^2 \]

\[ -4 \text{ missing part of COE} \]

- 2 wrong \( I \) (4.06 m/s)

- 2 wrong use of datum

8. (4 points) An Easter egg shaped plate can rotate freely about its center of mass located at the origin of the coordinate system. It has 3 forces applied as shown. The egg’s mass moment of inertia about its center of mass is 4.2 kg m². The point coordinates for the tail of each force vector is given in meters. What is its angular acceleration? (Use CW as positive)

\[ \sum \tau = I \alpha \]

\[ 80 \cdot 0 + (4 \cdot 50 \text{ Nm} \cos 25) (1 \text{ m}) + (-60 \cdot 25) (2.5 \text{ m}) = 4.2 \text{ kg m}^2 \cdot \alpha \]

\[ \alpha = -26.7 \text{ rad/s}^2 \]

- 2 using 30 \( \sin 25 \)
- 4 including 80 N
- 6 not using \( F_1 \)
- 4 not \( \div \) work \( I \)
- 2 wrong sign

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-4 including 80 N
-6 not using \( F_1 \)
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9. (14 pts) A car starts from rest and drives around a circular track, increasing its speed at a constant rate. It takes 45 seconds to complete 2 laps with a final speed of 88 ft/s. What is the radius of the track?

\[ 158 \text{ ft} \]

\[ \theta = 2 \text{rev} \cdot \frac{2\pi \text{ rad}}{1 \text{ rev}} = 12.566 \text{ rad} \]

\[ \theta = \frac{\omega_1 - \omega_2}{\Delta t} \quad \omega_1 = 0 \quad \omega_2 = \frac{88 \text{ ft/s}}{45 \text{ sec}} \]

\[ 12.566 \text{ rad} = \frac{\omega_2}{2} \cdot \frac{45 \text{ sec}}{2} \]

\[ \omega_2 = 0.5585 \text{ rad/sec} \]

\[ r = \frac{V_1}{\omega_2} = \frac{88 \text{ ft/sec}}{0.5585 \text{ rad/sec}} = 157.6 \text{ ft} \]

10. (16 pts) Determine the mass moment of inertia about point A for this 18 kg sign that is a rectangular plate of uniform thickness and density.

\[ 32.8 \text{ kg m}^2 \]

\[ I = I_{cm} + Md^2 \]

\[ = \frac{1}{12} m (a^2 + b^2) + Md^2 \]

\[ = \frac{1}{12} \left( \frac{18 \text{ kg}}{1.263} \right)(2.4^2 + 1.6^2) + \left( \frac{1.263}{1.263} \right)^2 \]

\[ = 32.82 \text{ kg m}^2 \]

\[ d = \sqrt{\left( \frac{1.6}{2} \right)^2 + \left( 2 \frac{1}{2} - 0.5 \right)^2} \]

\[ d = 1.063 \text{ m} \]

-8 not including \( Md^2 \) term
-4 wrong \( d \)
-2 forgot to divide by 12
-2 wrong size in \( I_{cm} \)